1879MNRAS..39..450S

Spectroscopic Observations of the Motion of Stars in the line of Sight, made at the Temple Observatory, Rugby.

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For some time past I have been engaged, whenever time would allow, in the spectroscopic estimation of the motion of stars towards and away from our system. The results I have obtained are very inconclusive; but I think it desirable, for the following reasons, that I should bring them before the notice of the Society without further delay. First, they are all *bonâ fide* attempts at correct measures and were carefully made, and a perusal of them, together with those of other observers, will show the wide difference of the results on the same star; and will prevent hasty conclusions based on the assumed accuracy of such measures, while they still show sufficient accordance to give some hope that, with increased instrumental power, accurate results may be obtained. Secondly, this paper is a contribution to the knowledge of the best methods of making delicate observations of this kind, and an account of early attempts shows what to avoid as well as what to do.

The instrument I have used in this research is a Newtonian Reflector of 12⅛ inches aperture and 6 feet 6 inches focal length, mounted equatoreally, and a Barlow lens is carried in the eye-piece, having an effect equivalent to doubling the focal length of the mirror. The spectroscope used has a collimating lens of ¾ inch diameter and 5 inches focal length, and the prisms are so arranged that the rays first traverse the lower part and then are reflected back through the upper part of them to the observing telescope. In my early measures a number equivalent to 4 of 60° were used, and a power of 15 on the observing telescope, but I have lately used 5 and 6 prisms (1 or 2 half-prisms and 2 whole ones of 60° twice over) and a power of 25.

I have tried many methods of comparison. I will enumerate the chief of them. First, the comparison light from the hydrogen vacuum tube was, by reflection, mixed with the rays from the star on the slit of the spectroscope; secondly, the comparison light was reflected on the slit by the side of the star, so that the spectra were viewed side by side. Both these methods rendered the detection of any noncoincidence easy; but the dark line of the spectrum of the star was often put out in the first method, and in the second the measurement of the displacement was difficult and uncertain when made with a bright-wire-micrometer both fixed in the eye-piece, and with the wires reflected by the surface of the last prism, so that the images only were seen. This was probably owing to the lines whose distances apart were to be measured not being side by side, and also being slightly curved.

I have therefore adopted the following method. The vacuum tube is carried by two wooden clips, which also embrace at their other extremities a glass rod fixed to the spectroscope in such a

1879MNRAS..39..450S

position that the tube can be swung at pleasure in front of the slit or below the level of the same; the spectrum of the star and that of the tube can then be viewed alternately by a slight motion of the latter. The displacement of the line is measured as follows:—A brass tube 8 inches long carries a collimating lens at one end, and in its focus at the other is a piece of tinfoil, with a minute hole in it, moved by a micrometer screw; the tube is so fixed that the spot of light from the tinfoil is reflected from one of the surfaces of the last prism, or the last but one, and is focussed in the eye-piece with the spectrum viewed. In the case of the first prism of the train being a half one with its surface last passed by the rays normal to the axis of the observing telescope, the last surface of the next one must be used for the purpose of reflecting the micrometer spot; and since it has then to pass through one half-prism to the observing telescope, it would be drawn out into a spectrum, if it were not illuminated by a monochromatic or nearly monochromatic light. The hole in the tinfoil is therefore illuminated by a small swing spirit lamp, with a coil of platinum wire holding common salt over the wick. The spectra of the star and tube are alternately thrown into the field, and the spot of light made to coincide with each in its turn, and the readings of the screw are noted; by subtraction the value of the displacement in terms of the divisions of the screw is then obtained. The value of the latter in wave-lengths is obtained by measuring the distance between the F-line and any other line of known position near it in the solar spectra, or by measurement of the distance between the magnesium lines produced by the electric spark. In my apparatus about 4 divisions of the screw correspond to an alteration of one tenth-metre in wave-length. The vacuum tube is placed with its length at right angles to the slit, the latter of which is placed so that the star would traverse its length by its apparent diurnal motion. A cylindrical lens is used in front of the slit, for I find a considerable width of spectrum advantageous, and conducive to accuracy. The foregoing arrangements work well under existing conditions here, but they are no doubt capable of improvement.

I would remark that a less dispersive power, or its equivalent, than that I have been using, seems to me to be almost valueless for anything like reliable results, and in fact a greater instrumental power is the thing now to be obtained; and since the image of a star does not increase in size by increase of aperture and corresponding focal length of telescope, assuming perfection of workmanship we may make the image of the star on the slit intrinsically brighter almost without optical limit, while leaving the angle of the cone of rays constant; an increase of aperture will therefore render the spectrum brighter, or enable a greater dispersive power to be used with undiminished brightness of spectrum.

The subjoined list of measures explains itself sufficiently, except perhaps as to the sixth column, headed "Corrected motion

1879MNRAS..39..450S

of Star," which contains the observed velocity of the star in miles per second, corrected for the value of the Earth's orbital motion, the sign + meaning that the star is receding from, and − approaching, our system.

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No.	Name of star.	No. of prisms.	Line compared.	No. of measures.	Corrected motion of star. Miles per sec.	Date 1800 +	Remarks.
1	γ Pegasi	5	F	2	+ 9·7	78·85	
2	Rigel	4	F	4	+29·3	77·15	Line badly defined.
3	γ Orionis	4	F	4	+41·58	77·05	
4	,,	5	F	4	+18·1	79·16	
5	δ Orionis	5	F	3	+54·3	79·16	
6	ε Orionis	5	F	3	+13·3	79·16	
7	ζ Orionis	5	F	3	+16·5	79·16	
8	α Orionis	4	b_4	3	−96·9	77·15	Moonlight; doubtful.
9	,,	4	F	2	+25·4	77·05	
10	,,	4	F	est.	+24·9	77·09	
11	,,	5	b_4	5	+32·9	79·17	
12	β Aurigæ	5	F	3	+ 0·6	79·17	Star line nebulous.
13	Sirius	4	F	2	+84·4	77·05	
14	Castor	6	F	2	+71·1	78·25	Star line hazy.
15	,,	5	F	3	+14·8	79·17	
16	,,	5	F	3	+23·7	79·25	
17	Pollux	4	F	2	+57·7	77·20	Very doubtful and faint.
18	,,	5	F	1	−27·7	79·17	Very doubtful.
19	,,	5	F	2	+26·6	79·25	
20	Procyon	4	F	5	−43·6	77·15	Moonlight.
21	,,	4	F	4	+ 2·2	77·20	
22	,,	4	F	2	+70·2	78·11	
23	,,	4	F	3	+22·8	78·24	
24	,,	6	F	2	+53·2	78·25	
25	,,	5	F	3	−45·1	79·16	
26	,,	5	F	4	+12·7	79·17	
27	,,	5	F	3	+43·1	79·25	
28	η Leonis	6	F	3	+21·9	78·31	
29	Regulus	6	F	3	+57·3	78·25	
30	,,	6	F	4	− 2·7	78·31	
31	,,	6	F	5	+67·8	78·33	
32	,,	5	F	5	+36·1	79·17	

1879MNRAS..39..450S

No.	Name of star.	No. of prisms.	Line compared.	No. of measures.	Corrected motion of star. Miles per sec.	Date 1800 +	Remarks.
33	„	5	F	3	+16·6	79·25	Line nebulous.
34	„	5	F	2	+27·0	79·33	
35	„	7	F	3	+35·1	79·33	
36	ε Ursæ Major.	5	F	3	−32·0	79·33	
37	δ Leonis	6	F	3	−59·5	78·33	
38	„	5	F	3	+ 8·18	79·33	Line nebulous.
39	θ Leonis	6	F	4	−67·4	78·33	Very doubtful and faint.
40	„	5	F	2	+44·6	79·33	Very faint and doubtful.
41	β Leonis	6	F	3	−73·5	78·25	Line very nebulous.
42	„	6	F	5	+32·2	78·31	„ „
43	„	6	F	3	+20·9	78·33	
44	„	5	F	3	−41·8	79·33	
45	η Ursæ Major.	6	F	4	+ 7·8	78·46	
46	Arcturus	4	b_1	2	+53·7	77·45	
47	„	6	b_1	1	−33·0	78·31	
48	„	7	F	3	− 7·2	79·33	
49	ζ Boötis	6	F	2	−27·3	78·47	Doubtful and very faint.
50	α Cor. Bor.	6	F	3	+ 6·5	78·46	
51	„	6	F	3	+22·3	78·47	
52	α Ophiuchi	6	F	3	−15·4	78·46	
53	Vega	4	F	4	−94·0	77·57	
54	„	6	F	3	−14·5	78·47	Doubtful.
55	„	6	F	6	−16·8	78·69	
56	„	6	F	4	−41·0	78·71	
57	Altair	6	F	3	−44·0	78·69	
58	„	6	F	4	+15·2	78·71	
59	„	6	F	3	+26·0	78·72	
60	δ Cygni	6	F	4	−29·4	78·71	
61	„	6	F	3	−57·8	78·72	
62	γ Cygni	6	F	3	−49·2	78·71	
63	„	6	F	4	−43·0	78·78	Doubtful.
64	ε Cygni	6	F	2	+20·2	78·78	
65	α Cygni	6	F	3	−39·1	78·69	
66	„	6	F	3	−56·9	78·71	
67	„	6	F	4	+45·5	787·8	Very doubtful.
68	„	5	F	4	−36·0	78·85	